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BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

COMPLETED

Are Management Problems In The Acquisition Of Aircraft Gas Turbine Engines Being Corrected ?

ORIGINAL

Problems in fighter/attack aircraft engines have been largely due to inadequate development concepts and procedures. Because the problems have been particularly costly and highly visible, the Navy and the Air Force have adopted new concepts and procedures which they are incorporating into formal policy, specification, and procedural documents. However, the standards, data base, and analytical procedures to implement the new concepts either have not been developed or have been incomplete.

The question is less what should be done, and more how and when it will be done? Answers to this question depend on top-level understanding, support, and direction within the services and the Office of the Secretary of Defense.

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COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

ARE MANAGEMENT PROBLEMS IN THE ACQUISITION OF AIRCRAFT GAS TURBINE ENGINES BEING CORRECTED?

D I G E S T

Recent problems with fighter/attack aircraft engines have been primarily due to development concepts, procedures, and practices that did not provide the time and money to (1) adequately develop the engines before production and use and (2) bring promising technology up to the point that it was ready for applications in new engines. Other major factors that adversely affected engine development were

--inadequate definition of the engines' usage and, consequently, the inability to design engines to their expected usage and to verify the design by testing to that usage;

--emphasis on performance requirements with a resulting lack of standards, data base, and analytical procedures to achieve a balance among performance, operability, reliability, durability, and costs; and

--inadequate flight testing of engines.

The cumulative result has been incomplete development before production, especially in regard to the engines' reliability, maintainability, and durability. Incomplete development, in turn, has resulted in extensive Component Improvement Programs (CIPs), increased spare parts costs, reduced operational readiness, and expensive retrofits.

F100 ENGINE DEVELOPMENT

Air Force performance requirements for the F100 engines, on F-15 aircraft, required application of promising but unproven technology that could not be fully developed within the $457 million, 6-year development program. Inadequate definition of the engine's usage, emphasis on performance requirements, and inadequate flight testing also contributed to incomplete engine development before production. As a result, the F-15 experienced engine problems that have

adversely affected fleet operational readiness and increased spare parts costs by $147 million. From 1974 to 1984, the Air Force will have spent about $665 million on CIPs to correct the problems. Although the costs to make improvements that may result from the CIPs could not be determined, the service estimates about $109 million for known improvements to its growing inventory of F100 engines through fiscal year 1981. (See pp. 8 to 11.)

F401 ENGINE DEVELOPMENT

Development of F401 engines for the Navy's F-14 was initiated in a joint program with the Air Force's development of the F100. The F401 was a larger version of the F100 engine and, like the F100, required the application of technology that could not be adequately developed within the program's funding and schedule constraints. The program was suspended in 1973 because of reported engine failures and funding constraints. The Navy states that it spent $369 million on developing the F401. (See pp. 11 and 12.)

TF30 ENGINE MODIFICATION

The TF30 engine, used on the F-111 aircraft, was to be modified for use as an interim engine on the first 33 F-14 aircraft. Development problems and subsequent suspension of the F401 engine program resulted in the use of the TF30 engine on all F-14s. To meet the F-14 airframe production schedule, modification of the TF30 engine was limited to 2 years and 5 months at a cost of $21 million. The specification for the TF30/F-14 engine excluded requirements for durability, reliability, and maintainability in spite of the operational problems experienced on the F-111. The engine was approved for production before many durability problems exhibited during qualification tests were corrected. Further, the contractor was not given mission profiles upon which to base the engine design modification until May 1972, 1 year after completing development. From the start of the engine's production in 1971 through 1985, the Navy will have spent about $840 million in developing and installing engine

modifications to correct safety of flight and durability problems. (See pp. 12 to 15.)

TF34 ENGINE MODIFICATION

Modification of the TF34 engine, used on the Navy's S-3A aircraft, to fit the Air Force's A-10 aircraft was a 2-year, 3-month effort that cost $14.5 million. The development period did not provide time to resolve several engine problems before production, and shortcuts were taken to reduce development testing. The Air Force version and its Navy predecessor continue to experience durability problems. By 1983, the Navy and Air Force will have spent about $210 million on CIPs for this engine. (See pp. 15 to 17.)

IMPROVEMENTS IN ENGINE DEVELOPMENT

Because of the extensive and costly F100 and TF30 problems that will extend into the mid-1980s and possibly longer, the services have implemented or are implementing the following improvements in engine development programs and CIPs:

--Better definition of missions and usage requirements.

--Emphasis on establishing structural integrity requirements.

--Expanded ground and flight testing before full-scale production.

--New emphasis on accelerated mission-type testing and accelerated flight schedules to identify usage problems so they can be corrected early in the operational phase.

These improvements represent a new approach to engine development that provides more time and money to reach Initial Operational Capability dates than was provided in the past. (See p. 19.)

The recent improvements are also present in CIPs and require additional funds to support accelerated mission tests and accelerated

flight programs. During fiscal year 1979 the Air Force was not achieving the utilization rate required by its F100 accelerated flight program, and consequently deficiencies may not be identified in time to develop corrective actions before the problems appear on the balance of engines in the inventory. (See pp. 26 and 27.)

The Navy does not have accelerated flight programs but instead performs trend analysis of engines inducted into the depot for repair/rework which are then correlated to the results of accelerated simulated mission endurance tests run on test stands.

STATUS OF NEW DEVELOPMENT CONCEPTS

The services' new approaches to engine development are being incorporated into formal policy, specification, and procedural documents. (See pp. 30 to 34.) However, actions to minimize technology constraints and fully implement the new development concepts are incomplete or have not been taken.

In the area of technology constraints, advanced development (technology demonstrator) programs have been consistently underfunded for structural testing of new designs and technology. Although the Congress appropriated $25 million above budget for durability-type testing during fiscal year 1980, the services' requests for fiscal year 1981 may not sustain the congressional initiative. If adequately supported, structural testing in the technology demonstrator programs could improve the technology base and risk assessment for new engine programs and result in less development failures, less costs, and shorter development times. (See pp. 36 to 41.)

Other key improvements needed to implement the new development concepts are development of a management standard, data base, and analytical procedures to identify and measure cost effectiveness of engines, systematic methods for reviewing and updating engine usage requirements and experience, and a system for tracking engineering changes. (See pp. 42 to 45.)

The above improvements would better enable advocates of the new approaches to

--quantify benefits and justify the additional testing and lengthening of the engine development process required by the new approaches;

--minimize the increased development time and costs by making the long empirical, iterative design process more rational and analytical; and

--improve contractor incentives by enabling the Government to specify logistical requirements in contractural terms. (Contractor incentives are discussed on pp. 45 to 48.)

RECOMMENDATIONS TO THE SECRETARY OF DEFENSE

GAO recommends that the Secretary of Defense delegate specific responsibility to an organization within his Office to direct and supervise the Air Force and Navy efforts to establish an organized and disciplined approach to the structural design, analysis, development, production, and life management of aircraft gas turbine engines. The designated organization should require the services to

--complete the formalization of their new policies, principles, and procedures for engine acquisition management by way of regulations and other appropriate documents;

--establish a master plan for developing the standards, supporting methodology, data base, and analytical procedures needed to fully implement the policies and principles and make the development process more rational and analytical;

--realine funding priorities to expand and improve advanced development programs in general and structural testing and development in particular; and

--coordinate their improvement efforts so as to enhance and encourage joint acquisition programs.

The designated organization should closely monitor the F101 Derivative Fighter Engine and Advanced Technology Engine joint programs. The Advanced Technology Engine program could be used as a pilot program to test and refine the services' new engine acquisition management concepts and to further develop and refine data collection and analytical procedures needed to produce more mature and cost-effective engines before full-scale production.

Because of the Congress' interest in the Air Force's and Navy's development and life management of aircraft gas turbine engines, GAO recommends that the Secretary of Defense periodically report to the Congress on its progress and problems in developing an organized and disciplined approach to the life management of aircraft gas turbine engines. The report should spell out the impact of the new approach on existing programs--CIPs, F101 Derivative Figher Engine, and Advance Technology Engine to provide the Congress information it needs to carry out its oversight responsibilities and to lessen its need to get more deeply involved in the Department of Defense's management of engine programs. The reporting could be made part of the annual authorization and appropriation hearings.

AGENCY AND CONTRACTOR COMMENTS

The Department of Defense and one of the two engine contractors invited to respond generally agreed with the facts and conclusions presented. (See pp. 54 and 55.) Defense, however, objected to GAO's recommendation for periodic reporting to the Congress on progress and problems in developing a new approach to the life management of aircraft gas turbines. Defense stated the current requirements for providing information to the Congress are sufficient. As explained on page 54, GAO believes that such reporting is warranted because of an expressed congressional interest in a more disciplined management approach and the need for Defense to demonstrate such an approach to

obtain timely and adequate support for future engine programs.

The contractor expressed concern that the study did not include some of the broader policy options and trade-offs that could be considered in engine development and raised questions about trade-offs in the acquisition of engines that should be made from a benefit/risk standpoint. GAO agrees that the greatest hindrances to engine development are time and money constraints and that deviations from an optimal engine development approach can be justified. This report is, however, geared toward the establishment of an organized and disciplined approach to the life management of aircraft gas turbine engines and not toward situations in which justifiable deviations can be allowed.

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ABBREVIATIONS

AMT	accelerated mission test
APSI	Aircraft Propulsion Subsystem Integration
ASMET	accelerated simulated mission endurance test
ATE	Advanced Technology Engine
ATEGG	Advanced Turbine Engine Gas Generator
CIP	Component Improvement Program
DFE	Derivative Fighter Engine
DOD	Department of Defense
ENSIP	Engine Structural Integrity Program
GAO	General Accounting Office
LTF	Lead-the-Force
PFRT	preliminary flight rating test
SMET	simulated mission endurance test